

1. The radiometer head assembly, which contains an antenna that views the sky, a calibrated reference target, a radio-frequency (RF) switch, a mixer, a local oscillator, and an intermediate-frequency (IF) amplifier—all these components are mounted together and attached to the inner surface of the aircraft fuselage, so that the antenna can observe the sky through a microwave-transparent window. The radiometer and antenna were ordered from a commercial vendor and modified at Ames to include an internal reference calibrator. Laboratory tests of this subassembly have indicated a signal-to-noise performance over a factor of two better than required.

2. The IF converter box assembly, which consists of IF filters, IF power splitters, RF amplifiers, RF power meters, analog amplifiers, analog-to-digital (A/D) converters, and an RS-232 serial interface driver—these electronics are mounted in a cabinet just under the radiometer head and connected to both the radiometer head and a dedicated WVM computer (CPU). All the flight electronic boards have been fabricated and have been shown

through testing to meet their requirements. A small microprocessor that handles the lowest-level data collection and timing has been programmed in assembly language to collect and co-add the radiometer data and communicate with the software residing in the WVM CPU.

3. A dedicated WVM CPU that converts the radiometer measurements to measured microns of precipitable water and communicates with the rest of the SOFIA Mission and Communications Control System (MCCS)—a nonflight version of this computer hardware has been procured for laboratory testing and the flight software is under development, with approximately 60% of the software coded and unit tested. Proper command and data communications between the WVM and the SOFIA MCCS have been demonstrated using an MCCS simulator that was developed by the SOFIA Project and is located on site at Ames.

Point of Contact: T. Roellig
(650) 604-6426
troellig@mail.arc.nasa.gov

New Interstellar Simulation Chamber Cavity Ring-Down Spectroscopy of Interstellar Organic Materials

Farid Salama, Ludovic Biennier, Robert Walker, Lou Allamandola, Jim Scherer, Anthony O'Keefe

A major milestone has just been achieved at Ames Research Center: a new facility has been developed to directly simulate gaseous molecules and ions at the low temperature and pressure conditions of interstellar space. This laboratory facility—which is unique within NASA—combines the techniques of supersonic free-jet expansion spectroscopy (JES) with the techniques of cavity ring-down absorption spectroscopy (CRDS). The principal objective is to determine the spectroscopic properties of

large interstellar aromatic molecules and ions under conditions that precisely mimic interstellar conditions. The aim of this research is to provide quantitative information to analyze astronomical spectra in support of NASA's Space Science and Astrobiology missions, including data taken with the Hubble Space Telescope.

Understanding the origin, physical properties, and distribution of the most complex organic

compounds in the universe is a central goal of Astrophysics and Astrobiology. Achieving this understanding requires the generation and maintenance of large carbon-containing molecules and ions under interstellar-like conditions with simultaneous measurement of their spectra under these conditions (that is, in the gas phase at very low densities and at very low temperature). As an aside, these organic structures are those that constitute the building blocks of carbon nanotubes. This process has been accomplished by combining three advanced techniques: free supersonic jet expansion, low-temperature plasma formation, and the ultrasensitive technique of cavity ring-down spectroscopy. The new facility thus comprises a pulsed-discharge, supersonic slit-jet source mounted in a high-flow vacuum chamber and coupled to a cavity ring-down spectrometer. Under these experimental

conditions, a beam of argon or helium gas seeded with polycyclic aromatic hydrocarbon molecules (PAHs) is expanded in the gas phase into the cavity ring-down chamber. When the expanding beam is exposed to a high-voltage ionizing electronic discharge, positively charged ions are formed that are characterized by very low, interstellar-like, rotational and vibrational temperatures (temperatures of the order of 10 and 100 kelvin (K), respectively, are achieved this way, as shown in figure 1). The cavity ring-down signal is a direct measurement of the absolute absorption by the seeding molecules and ions. This fact is illustrated in figure 2, which shows the spectrum of the PAH naphthalene ion ($C_{10}H_8^+$). This unique experimental facility has been developed in collaboration with Los Gatos Research through a Small Business Innovative Research contract.

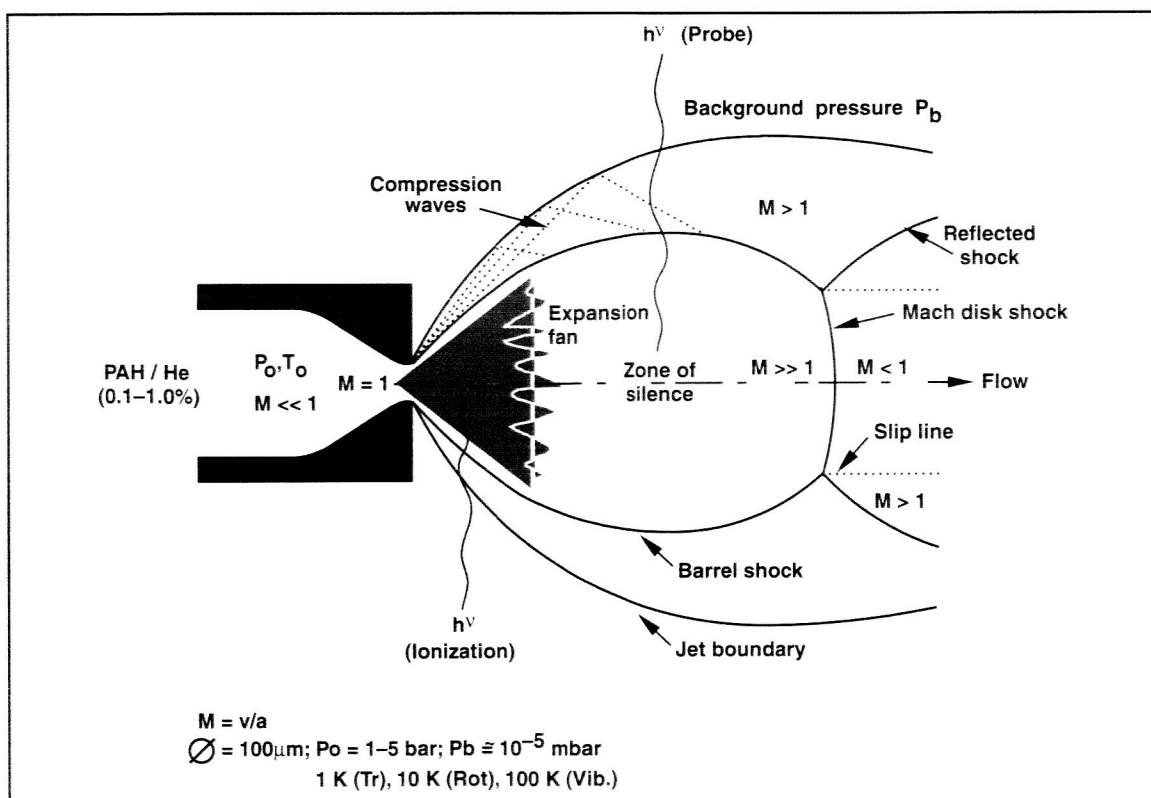


Fig. 1. Location of the "zone of silence" in a supersonic free jet expansion. The physical conditions within the boundaries of the "zone of silence" approach interstellar conditions.

The data shown in figure 2 can now be used to analyze the astronomical spectra. For example, the absorption band of the PAH ion ($C_{10}H_8^+$) shown in figure 2 can be directly compared to the absorption spectrum of the diffuse interstellar bands. These bands, which contribute to the global interstellar extinction, were discovered 80 years ago and remain an enigma to this day.

For the first time, the absorption spectrum of large organic molecules and ions can be measured under conditions that mimic entirely the interstellar conditions.

Point of Contact: F. Salama
(650) 604-3384
fsalama@mail.arc.nasa.gov

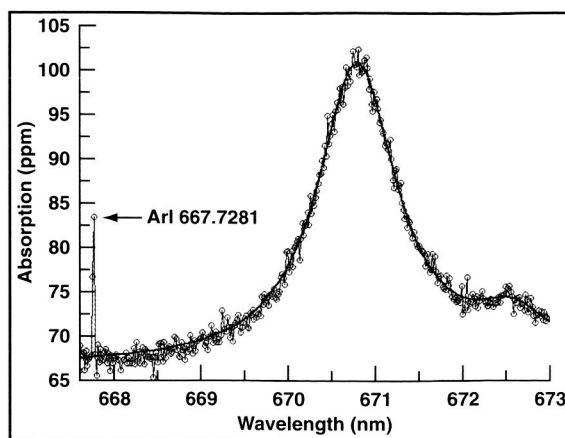


Fig. 2. The CRDS absorption spectrum of the naphthalene cation ($C_{10}H_8^+$) under simulated interstellar space conditions. The spectrum is obtained when an argon free jet expansion seeded with naphthalene is exposed to a high-voltage discharge. Note the absorption line of metastable argon that is used for internal wavelength calibration.

SPACE TECHNOLOGY

Carbon Nanotube Deposition and Growth Technique

Lance Delzeit

Carbon nanotubes (NTs) possess electrical, mechanical, and physical properties that make them ideal for applications in nanotechnology. A major constraint to the realization of many of these applications is the ability to produce nanotubes in an industrially viable method with the characteristics desired for the given application. These characteristics include quantity, chirality, size, density, distribution, and purity of the nanotubes produced. The research described here focuses on the production of NTs with the desired density, distribution, and purity for the application to industrially viable products.

A catalyst deposition and growth technique has been developed that allows for the controlled growth of either single- or multiwalled carbon nanotubes. This technique uses ion-beam sputtering to deposit the catalyst. By changing the catalyst formula and the growth conditions, either single- or multiwalled carbon nanotubes

can be grown. Furthermore, by adjusting the conditions used to produce single-walled nanotubes, the density of the nanotubes grown can be controlled from a sparse distribution of individual single-walled nanotubes to dense mats of single-walled nanotube "ropes." "Ropes" are an association of individual nanotubes that form a larger structure—just as individual fibers make up a normal rope. The conditions for the growth of multiwalled nanotubes have been optimized for the growth of "towers." A "tower" is a structure in which the nanotubes grow in the vertical direction because of the high density of the nanotubes in that region. Each of these different structures has applications to a variety of devices.

A further advantage of this technique is the ability to pattern the catalyst onto the surface. If the application requires the nanotubes to be grown in a confined area, then the ability to restrict the deposition of the catalyst to those